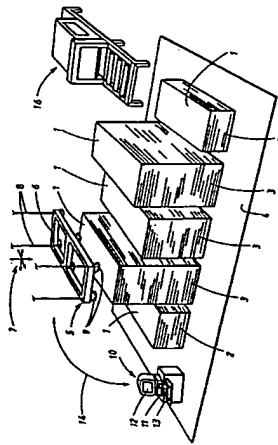


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(57) Abstract

Method for storage handling of stackable storage objects (1), where the storage objects are supplied to a store in an arrival stack (2); the storage objects are stored in at least three storage stacks (3); the storage objects (1) are moved between the said arrival stack (2) and the storage stacks (3) by means of a collector (5) provided with means (9) for securing and releasing the storage objects; a control unit (10) provided with a processor controls the movements of the collector (5) via a communications link (14) and in accordance with instructions from a user, which instructions are input to the control unit (10) via a user interface (12, 13) coupled thereto; upon arrival of storage objects in the said arrival stack (2), the control unit (10) is fed with information on the individual identity of each storage object; its type and its position in the arrival stack (2); the said instructions include withdrawal order which are arranged in a withdrawal list in the control unit (10) in the desired sequence, each withdrawal order concerning a storage object of a certain type. The invention is characterized in particular by the fact that the method takes place in three main stages, namely marking, withdrawal and sorting.

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METHOD FOR STORAGE HANDLING OF STACKABLE STORAGE OBJECTS

TECHNICAL FIELD

The present invention relates to a method for storage handling of stackable storage objects such as, for example, metal sheets. The invention can advantageously be used in the central warehouse of a metal sheet user or in the collection depot of a steel wholesaler. Alternatively, the invention can also be advantageously applied in production stores in direct connection with one or more processing machines.

In storage handling of metal sheets it is customary, according to known techniques, to use a so-called level store in which metal sheets are stored on pallets. The store comprises a number of shelves or compartments arranged laterally and vertically. Here, sheets of a certain type and size – normally characterized by a specific article number – are stored on a pallet. Sheets with different article numbers are not normally stored on the same pallet. The actual storage handling in a level store of this type is normally carried out using trucks. A problem with such a level store is that it requires large storage surfaces in the storage premises, partly because each shelf position or compartment is intended only to accommodate sheets of the same article number and partly because the trucks require a relatively large manoeuvring space around the storage shelves. In addition, the operating costs for the trucks are not insignificant, irrespective of whether the trucks used are driver-operated or driverless. In brief, a level store with truck operation entails relatively high storage costs.

In smaller plants, it is customary for different types of sheets to be stored vertically in stands in which the sheets lean against vertical support pins. Since the sheets are usually transported and delivered to the plant in a horizontal position, they have to be lifted by the warehouse personnel on arrival. The customary manual handling therefore entails handling difficulties and risks of accidents, since the sheets are often heavy and it is difficult to grip a vertical sheet in the centre of gravity before lifting it. In addition, the sheets generally have to be laid down horizontally again

before leaving the store.

DESCRIPTION OF THE INVENTION

5 The invention solves the above problems by providing a method for storage handling of stackable storage objects in accordance with attached Patent Claim 1. The invention permits extremely cost-effective storage handling in a small surface area in relation to previously known storage handling systems.

10 According to the invention, the storage area can be made particularly compact by virtue of the fact that storage objects with different article numbers can be stored in one and the same storage stack. In addition, the invention eliminates the need for extensive shelf systems and pallets since the storage objects can be placed directly of the floor surface of the storage area. In this way, the weight of the storage stacks is also distributed over a greater area of the floor, which is favourable if there are any limitations in the load-bearing capacity of the floor.

20 The storage handling according to the invention is largely automated and is controlled by a control unit which is provided with a processor and which, via a communications link, controls a collector device in accordance with instructions from the user. When a withdrawal order relating to a certain article number or a series of different article numbers is obtained, the storage objects wanted are rapidly and effectively sorted out in the desired order of use.

A further advantage of the invention is that the storage handling requires only very limited supervision and involvement by the user, since the sorting in the storage area takes place automatically in the method according to the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

35 The invention will be described below on the basis of an illustrative embodiment and with reference to the attached drawings, in which:

Figure 1 shows diagrammatically a store adapted to the method according to the invention, and a diagrammatically illustrated processing machine at

- 3 -

the side of the store, representing a dispatch position in the store;

Figure 2 shows diagrammatically a simplified image of a store in which the various storage objects have been marked with article numbers. The storage stack located on the far left in this case represents an arrival stack, the other four stacks representing storage stacks. The illustrated positions of the storage objects represent a randomly selected starting point for the following explanation of the method according to the invention;

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Figures 3 - 10 show the successive transfer operations, starting from Figure 2, which are carried out in the method according to the invention. The final figure, i.e. Figure 10, thus shows the store in the state when the sorting has been accomplished according to the withdrawal list.

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DESCRIPTION OF PREFERRED EMBODIMENT

Figure 1 shows a diagrammatic representation of a store containing storage objects in the form of metal sheets. The storage objects are generally designated by reference number 1. The store contains an arrival stack 2 and four storage stacks 3. However, only three stacks are needed for the method according to the invention to be able to function, but since the number of sorting stages increases with a minimum number of storage stacks, four storage stacks are used in the embodiment in order to illustrate the method. It can also be seen from Figure 1 that the storage stacks 3 and the arrival stack 2 are placed directly on a store floor 4. Thus, the method according to the invention does not require the use of loading pallets or lateral guides in the form of boundary walls, rails etc. The storage stacks 3 can advantageously be placed in close proximity to each other in such a way that the available floor space in the store is utilized effectively.

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The storage objects 1 are moved between the said arrival stack 2 and the storage stacks 3 by means of a collector 5, for example consisting of a lifting frame 6 which is movably connected to a crossbar arrangement (not shown) suspended over the store area. The collector 5 can be raised and lowered and can also be moved in the horizontal plane according to the arrows 7. In the example shown, the collector 5 is suspended on cables 8 which, in the figure, are not shown in full since the crossbar pieces of the

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collector 5 are not shown. The collector 5 is provided with means for securing and releasing the storage objects 1, these means being in the form of suction cups 9 which are thus intended to hold the storage objects 1 by means of a vacuum which is generated in a known manner using ejectors driven by compressed air. However, the collector 5 can also be equipped with holder members provided with electromagnets. Moreover, in the case where the storage objects 1 consist instead of, for example, trays with retail contents, the collector 5 can also be equipped with traditional gripping members which physically grip onto coupling members on the tray.

10

A storage system applying the method according to the invention also includes a control unit 10 which is provided with a processor and preferably consists of a generally available personal computer or computer work station of a conventional type. The control unit 10 thus comprises a systems unit 11 and a user interface connected thereto and including a computer screen 12 and a keyboard 13. The control unit 10 controls the movements of the collector 5 in accordance with instructions from a user, which are input to the control unit via the said user interface 12, 13. The control unit 10 is in contact with the collector 5 via a communications link 14 which, in Figure 1, is shown diagrammatically by a two-way arrow.

20

A processing station 16 placed outside the storage floor area 4 is also shown diagrammatically in Figure 1. In the example shown, the processing station 16 constitutes the final destination of the storage objects which are delivered from the store. However, depending on the store's use, the processing station 16 can instead consist of a dispatch point or a goods vehicle for transporting and delivering the storage objects to the actual end-user.

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When storage objects 1 arrive in the said arrival stack 2, the control unit 10 is fed with information on the individual identity of each storage object, its type and its position in the arrival stack 2. The instructions include withdrawal orders which are arranged in a withdrawal list in the control unit. The said withdrawal orders are arranged in the withdrawal list in the desired sequence, in which each withdrawal order concerns a storage object 1 of a certain type. The term "type" used here is a collective term for storage objects having identical dimensions, for example. Storage objects of a specific type are normally assigned a special article number, which

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- 5 -

thus characterizes the type. The term "desired sequence" includes the situation where storage objects with the desired article number are arranged in a desired sequence and also the situation where the sequence is determined by the times at which different storage objects have been requested by the user. In the latter case, earlier withdrawal orders are executed before later withdrawal orders.

The method according to the invention for storage handling will now be described in more detail with reference to Figures 2 - 10. Figure 2 shows a randomly selected starting point for the method, where diagrammatically represented storage objects 1 have been provided with eleven different article numbers. The stack on the far left of the figure is an arrival stack 2, while the other four stacks are storage stacks 3. In the starting position shown, the storage objects 1 are lying unsorted in the storage stacks 3 and the imagined situation is that the arrival stack 2 has just been filled with six storage objects of article number 11. The storage objects which are delivered to the store are first placed on the arrival stack 2, and the user enters information on the individual identity of each storage object, its type and its position in the arrival stack 2. The term individual identity can here cover a number of parameters, for example the length, width, thickness, weight, quality, supplier, surface treatment, project allocation, charge on batch number, price and arrival date of the storage object 1. It should also be added here that in a preferred embodiment the collector 5, which is shown in Figure 1, comprises means for identifying the storage objects 1, for example in the form of an arrangement for weighing the storage objects. This means that the collector 5 emits signals to the control unit 10 concerning the weight of the secured storage object which, in the context of the handling of metal sheets, is often a clear identifier of the type of sheet, since the sheet dimensions and density are previously known and recorded under the given article number in the control unit 10. In other applications where storage objects of other types are used, the collector 5 can be equipped, for example, with bar-code scanners or other optical scanning means. Scanning means of an electronic type, for example comprising microchip marking of the storage objects, can of course also be used.

The following is a withdrawal list which has been set up to illustrate the method according to the invention:

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Sequence number 1	Art No 2
Sequence number 2	Art No 7
Sequence number 3	Art No 9
Sequence number 4	Art No 3
Sequence number 5	Art No 8
Sequence number 6	Art No 7
Sequence number 7	Art No 10
Sequence number 8	Art No 1
Sequence number 9	Art No 6
Sequence number 10	Art No 5
Sequence number 11	Art No 5
Sequence number 12	Art No 7
Sequence number 13	Art No 4
Sequence number 14	Art No 2
Sequence number 15	Art No 6

The top line in the withdrawal list represents the withdrawal order which is to be executed first according to the user's requirements. The withdrawal order thus consists of a sequence number and an associated article number. Thus, in the example described, we have a withdrawal list comprising fifteen withdrawal orders.

Consequently, there are also sequence numbers from 1 to 15, each coupled to a desired article number. Starting from the situation in Figure 2, and with a given withdrawal list according to Figure 3, the method will be explained below in stages. The method comprises the following four main stages: marking, collection, arrival and sorting.

The first main stage, marking, commences in stage 1, in which the control unit 10 searches for the first unmarked storage object 1 which is requested in the withdrawal order which is in turn in the withdrawal list and which unmarked storage object lies at the top of one of the said storage stacks 3 and/or in the arrival stack 2. It should be noted here that the control unit 10 detects the individual position of each storage object 1 in the store. The starting position and stage 1 are illustrated in Figure 2.

In stage 2, which is shown in Figure 3, the control unit 10, in an internal register, marks the storage object 1 searched in stage 1 with a sequence number according to the withdrawal order. In Figure 3, the designation

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"sequence number" has been shortened to "seq" for reasons of space. Stages 1 and 2 are repeated for as long as there are requested unmarked storage objects in the store.

5 In stage 3, the control unit 10 defines the storage stack which has the lowest positioned unmarked storage object 1 above a storage object marked in stage 2, and assigns this storage stack 3 a first category (A) and assigns other storage stacks a second category (B). The division into stack categories is also shown in Figure 3.

10 The second stage, collection, now commences:

Referring to Figures 3 and 4, stage 4 proceeds as follows: if in the storage stack 3 of the first category (A) there are one or more unmarked storage objects 1 above the lowest marked storage object 1, the collector 5 moves an unmarked or a marked storage object to a storage stack 3 of the said second category (B). Stage 4 is repeated until no unmarked storage objects 1 lie above the said lowest marked storage object in the storage stack 1 of the first category (A).

20 Thus, in Figure 5, storage objects have been moved across from the storage stack of the first category (A) to other storage stacks of the second category (B) in such a way that no unmarked storage objects lie above the lowest marked storage object - in the example sequence number 12 with article number 7. The situation shown in Figure 4 illustrates the store when the first phase of collection has been completed.

Referring to Figures 4, 5 and 6 in succession, the second phase of collection then proceeds as follows in stage 5: if, in any storage stack 3 of the second category (B), there is a marked storage object 1, the collector moves - from the lowest storage stack of the said category (B) which contains a marked storage object - an unmarked storage object in this storage stack to a second storage stack of the same category (B), or a marked storage object to a storage stack of the said first category (A). Figure 5 shows the situation when the second phase of collection has been carried out according to stage 5. Stage 5 is repeated until all the marked storage objects 1 are in the storage stack 3 of the first category (A). Collection is then completed, which phase is shown in Figure 6.

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Referring to Figures 6 and 7, the second main stage of the method, storage, is carried out in stage 6 by means of the collector 5 moving the storage objects 1 lying in the arrival stack 2 to one or more storage stacks of the second category (B). Allocation to the respective stack or storage stack of the second category (B) can be done randomly. Stage 6 is repeated until the arrival stack 2 is empty, which situation is illustrated in Figure 7. The arrival stage is thus completed.

Referring to Figures 7 and 8, the third main stage of the method, sorting, now commences in stage 7, where the collector 5 moves the uppermost marked storage object 1 from the storage stack of the first category (A) to a storage stack 3 of the second category (B) on which a marked storage object, with the next higher sequence number in relation to the storage object which is moved, lies at the top.

15 Stage 8: if the condition for moving according to stage 7 is not satisfied, the collector moves the uppermost marked storage object 1 from the storage stack 3 of the first category (A) to a storage stack of the second category (B) which has no marked storage object 1.

20 Stage 9: if the condition for moving according to stage 8 is not satisfied, the collector 5 moves the uppermost marked storage object 1 from the storage stack 3 of the first category (A) to the storage stack 3 of the second category (B) whose uppermost marked storage object has the lowest sequence number in relation to the uppermost marked storage objects of the other storage stacks 3 of the same category (B).

Stages 7 to 9 are repeated until the storage stack 3 of the first category (A) has no marked storage objects. This situation is illustrated in Figure 8.

30 Stage 10: if all the marked storage objects lie in storage stacks of category (B), on marked storage objects with a higher sequence number than their own sequence number or on an unmarked storage object 1, the sorting is completed, otherwise the sorting continues in accordance with stage 11 below. In the example shown, we are now at Figure 8. Since the condition according to stage 10 is still not satisfied, the sorting therefore continues according to stage 11 described below.

Stage 11: the collector 5 moves the storage object, which among the uppermost marked storage objects in the storage stacks of the second category (B) has a sequence number which is next higher than the sequence number of the storage object lying at the top of the storage stack 3 of the first category (A), to the storage stack 3 of the first category (A).

Stage 12: if the condition for moving in accordance with stage 11 is not satisfied, the collector 5 moves the storage object 1, which among the uppermost marked storage objects in the storage stacks 3 of the second category (B) has the lowest sequence number, back to the storage stack 3 of the first category (A).

Stages 11 and 12 are repeated until all the marked storage objects are lying in the storage stack of the first category (A). This situation has been reached in Figure 9.

Stage 13: the sorting continues from stage 7, i.e. the collector 5 moves the uppermost marked storage object 1 from the storage stack of the first category (A) to a storage stack of the second category (B) on which a marked storage object 1, with the next higher sequence number in relation to the storage object which is moved, lies at the top. In the example shown, the sorting is now finished and the storage objects lie sorted in the storage stacks in such a way that the collector 5, at the time of delivery from the store, is able to pick up the storage objects in sequence according to the desired withdrawal list. In this example, the collector 5 thus first picks up the storage object with sequence number 1 and article number 2 from the storage stack of the second category (B) situated furthest to the right, after which the collector 5 picks up the storage object with sequence number 2 and article number 7 from the storage stack of the second category (B) situated furthest to the left. The collector then returns to the storage stack situated furthest to the left in order to deliver the storage object with sequence number 3 and article number 9. The delivery is then continued according to the same pattern until all the withdrawal orders in the withdrawal list have been executed. In the method according to the invention, it is therefore not necessary for all the storage objects present in the withdrawal list to be lying in one and the same storage stack at the end of sorting.

The invention is not limited to the illustrative embodiment described above and shown in the drawings, but can be freely varied within the scope of the attached patent claim.

Patent Claim

- 5 1. Method for storage handling of stackable storage objects (1), where
- the storage objects are supplied to a store in an arrival stack (2);
 - the storage objects are stored in at least three storage stacks (3);
 - the storage objects (1) are moved between the said arrival stack (2) and the storage stacks (3) by means of a collector (5) provided with means (9) for securing and releasing the storage objects;
 - a control unit (10) provided with a processor controls the movements of the collector (5) via a communications link (14) and in accordance with instructions from a user, which instructions are input to the control unit (10) via a user interface (12, 13) coupled thereto;
 - upon arrival of storage objects in the said arrival stack (2), the control unit (10) is fed with information on the individual identity of each storage object, its type and its position in the arrival stack (2);
 - the said instructions include withdrawal orders which are arranged in a withdrawal list in the control unit (10) in the desired sequence, each withdrawal order concerning a storage object of a certain type,

characterized in,

- 25 that the method takes place in the following stages:

(marking)

- 30 stage 1: the control unit (10) searches for the first unmarked storage object (1) which is requested in the withdrawal order lying next in the withdrawal list and which lies at the top of one of the said storage stacks (3) and/or the arrival stack (2);

- 35 stage 2: in an internal register, the control unit (10) marks the storage object (1) found in stage 1 with a sequence number according to the withdrawal order desired in the withdrawal sequence;

stages 1 and 2 are repeated as long as there are requested unmarked storage objects

- stage 3: the control unit (10) defines the storage stack (1) which has the lowest unmarked storage object above a storage object marked in stage 2 and assigns this storage stack a first category (A) and assigns other storage stacks (3) a second category (B);

(withdrawal)

- stage 4: if in the storage stack (3) of the first category (A) there are one or more unmarked storage objects (1) above the lowest marked storage object, the collector moves an unmarked or a marked storage object to a storage stack of the said second category (B);

- ***stage 4 is repeated until no unmarked storage objects lie above the said lowest marked storage object in the storage stack of the first category (A)***

- stage 5: if, in any storage stack (3) of the second category (B), there is a marked storage object (1), the collector moves from the lowest storage stack of the said category (B), which contains a marked storage object, an unmarked storage object in this storage stack to a second storage stack (3) of the same category (B), or a marked storage object to a storage stack of the said first category (A);

- ***stage 5 is repeated until all the marked storage objects are in the storage stack of the first category (A)***

(arrival)

- stage 6: the collector (5) moves storage objects lying in the arrival stack (2) to one or more storage stacks (3) of the second category (B);

- ***stage 6 is repeated until the arrival stack is empty***

(sorting)

- stage 7: the collector (5) moves the uppermost marked storage object (1) from the storage stack of the first category (A) to a storage stack of the second category (B) on which a marked storage object, with the next

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higher sequence number in relation to the storage object which is moved, lies at the top;

5 stage 8: if the condition for moving according to stage 7 is not satisfied, the collector (5) moves the uppermost marked storage object (1) from the storage stack of the first category (A) to a storage stack (3) of the second category (B) which has no marked storage object;

10 stage 9: if the condition for moving according to stage 8 is not satisfied, the collector (5) moves the uppermost marked storage object (1) from the storage stack of the first category (A) to that storage stack of the second category (B) whose uppermost marked storage object has the lowest sequence number in relation to the uppermost marked storage objects of the other storage stacks (3) of the same category (B);

15

stages 7 - 9 are repeated until the storage stack of the first category (A) has no marked storage objects

20 stage 10: if all the marked storage objects (1) lie in storage stacks (3) of the second category (B), on marked storage objects with a higher sequence number than their own sequence number or on an unmarked storage object, the sorting is terminated, otherwise the sorting continues in accordance with stage 11;

25 stage 11: the collector (15) moves the storage object (1) which, among the uppermost marked storage objects in the storage stacks (3) of the second category (B) has a sequence number which is next higher than the sequence number of the storage object lying at the top of the storage stack of the first category (A), to the storage stack (3) of the first category (A);

30

stage 12: if the condition for moving in accordance with stage 11 is not satisfied, the collector (5) moves the storage object (1) which, among the uppermost marked storage objects in the storage stacks (3) of the second category (B) has the lowest sequence number, back to the storage stack (3) of the first category (A);

35

stages 11 and 12 are repeated until all the marked storage objects (1) are lying in the storage stack (3) of the first category (A)

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stage 13: the sorting continues from stage 7.

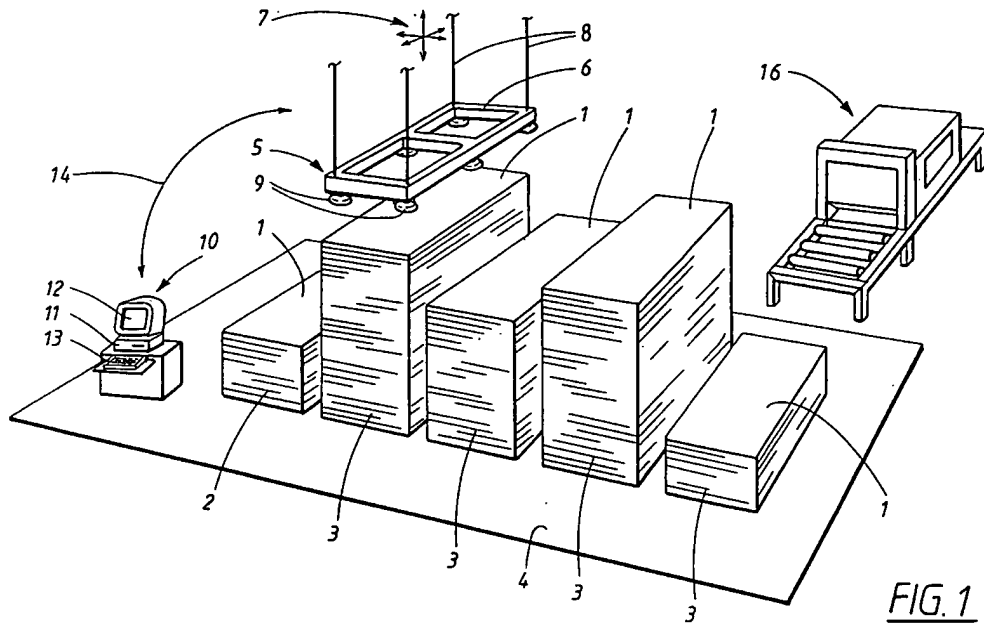


FIG. 1

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Art No 11	Art No 2		Art No 3	Art No 2
Art No 11	Art No 4		Art No 9	Art No 8
Art No 11	Art No 3		Art No 3	Art No 3
Art No 11	Art No 7	Art No 7	Art No 5	Art No 1
Art No 11	Art No 5	Art No 1	Art No 8	Art No 2
Art No 11	Art No 1	Art No 2	Art No 3	Art No 1
Art No 11	Art No 3	Art No 9	Art No 8	Art No 2
Art No 11	Art No 6	Art No 1	Art No 5	Art No 10
Art No 11	Art No 9	Art No 3	Art No 2	Art No 1
Art No 11	Art No 6	Art No 2	Art No 2	Art No 4
Art No 11	Art No 3	Art No 6	Art No 2	Art No 3
Art No 11	Art No 10	Art No 6	Art No 1	Art No 7
Art No 11	Art No 4	Art No 7	Art No 2	Art No 4
Art No 11	Art No 1	Art No 6	Art No 2	Art No 4
Art No 11	Art No 7	Art No 6	Art No 2	Art No 10

FIG. 2

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	Seq 14 - Art No 2		Art No 3	
	Seq 13 - Art No 4		Seq 3 - Art No 9	Seq 1 - Art No 2
	Seq 4 - Art No 3		Art No 3	Seq 5 - Art No 8
	Seq 6 - Art No 7		Seq 10 - Art No 5	Art No 3
	Seq 11 - Art No 5		Art No 8	Art No 1
	Art No 1		Art No 3	Art No 2
	Art No 3		Art No 8	Art No 1
	Art No 1		Art No 8	Art No 2
	Seq 9 - Art No 6	Seq 2 - Art No 7	Art No 5	Seq 7 - Art No 10
	Art No 9	Seq 8 - Art No 1	Art No 2	Art No 1
	Art No 6	Art No 2	Art No 2	Art No 4
	Art No 3	Art No 9	Art No 2	Art No 3
	Art No 9	Art No 1	Art No 2	Seq 12 - Art No 7
	Art No 3	Art No 1	Art No 1	Art No 4
	Art No 10	Art No 3	Art No 2	Art No 4
	Art No 10	Art No 2	Art No 2	Art No 10
	Art No 9	Art No 6		
Art No 11	Art No 4	Seq 15 - Art No 6		
Art No 11	Art No 1	Art No 3		
Art No 11	Art No 1	Art No 7		
Art No 11	Art No 7	Art No 6		

BBBA

FIG. 3

	Seq 7 - Art No 10		Art No 3	
	Art No 3		Art No 1	
	Seq 14 - Art No 2		Art No 2	
	Seq 13 - Art No 4		Seq 1 - Art No 2	
	Seq 4 - Art No 3		Art No 3	
	Seq 6 - Art No 7		Seq 3 - Art No 9	
	Seq 11 - Art No 5		Art No 3	
	Art No 1	Art No 4	Seq 10 - Art No 5	
	Art No 3	Art No 1	Art No 8	
	Art No 1	Art No 2	Art No 3	
	Seq 9 - Art No 6	Seq 5 - Art No 8	Art No 8	
	Art No 9	Seq 2 - Art No 7	Art No 5	
	Art No 6	Seq 8 - Art No 1	Art No 2	
	Art No 3	Art No 2	Art No 2	
	Art No 9	Art No 9	Art No 2	
	Art No 3	Art No 1	Art No 2	
	Art No 10	Art No 3	Art No 2	
	Art No 10	Art No 2		
	Art No 9	Art No 6		
Art No 11	Art No 4	Seq 15 - Art No 6		
Art No 11	Art No 1	Art No 3		
Art No 11	Art No 1	Art No 7		
Art No 11	Art No 7	Art No 6		

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FIG. 4

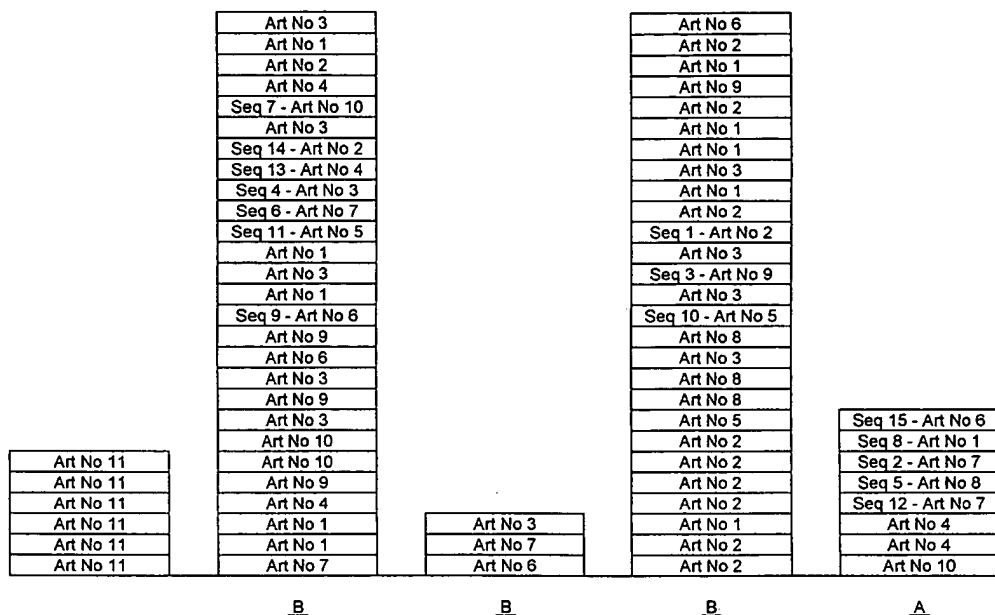


FIG. 5

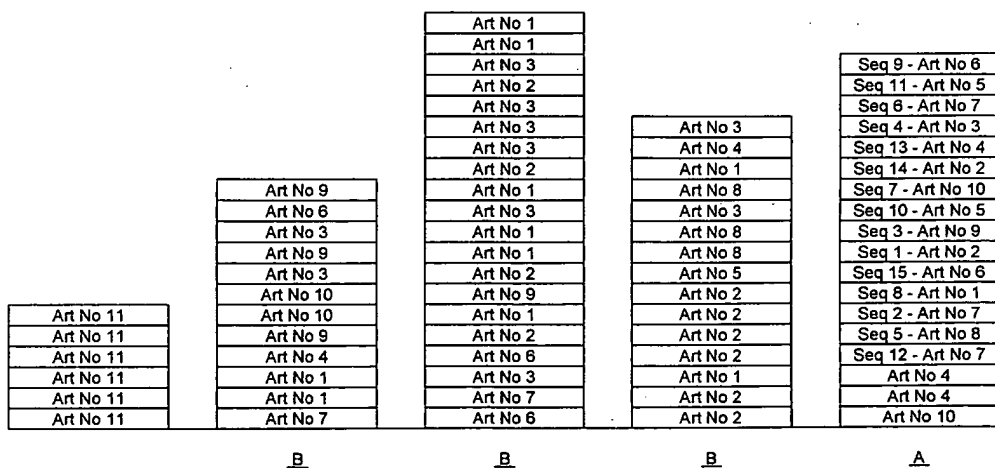


FIG. 6

FIG. 7

FIG. 8

